R E P O R T R E S U M E S

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COMPUTER ASSISTED MATHEMATICS INSTRUCTION, PILOT PROJECT.
CONNECTICUT STATE DEPT. OF EDUCATION, HARTFORD

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DESCRIPTORS- *COMPUTER ASSISTED INSTRUCTION, *CURRICULUM DEVELOPMENT, *MATHEMATICS, *SECONDARY SCHOOL MATHEMATICS, COMPUTERS, TEACHER EDUCATION,

THIS DOCUMENT REPORTS AN INITIAL EXPERIMENT WITH THE USE OF A LARGE SCALE COMPUTER AS A MEANS OF TEACHING MATHEMATICS IN THREE SELECTED HIGH SCHOOLS FROM THREE CONNECTICUT COMMUNITIES. ANSWERS TO THESE BASIC QUESTIONS WERE SOUGHT IN THE EXPERIMENT--(1) HOW CAN MATHEMATICAL UNDERSTANDINGS AND LOGIC BE TAUGHT MORE EFFECTIVELY WITH THE USE OF THE COMPUTER, (2) HOW CAN THE COMPUTER BE PROGRAMED TO ACT AS A USEFUL INSTRUCTION AID, (3) WHAT TRAINING IS NECESSARY FOR TEACHERS TO ENABLE THEM TO USE THIS TOOL SUCCESSFULY, AND (4) WHAT IMPLICATIONS DOES COMPUTER INSTRUCTION HAVE FOR VARIOUS AREAS OF THE CURRICULUM AND OTHER AGE GROUPS. THE TWO TELECOMP SYSTEMS WHICH WERE SET UP IN EACH SCHOOL WERE USED (1) TO ASSIST IN THE DISCOVERY APPROACH TO DEVELOP UNDERSTANDING OF MATHEMATICAL CONCEPTS, (2) TO EMPHASIZE THE ANALYSIS OF PROBLEMS INTO SUB-PROBLEMS, AND (3) TO DE-EMPHASIZE THE ROUTINE DRILL APPROACH TO MATHEMATICS. SOME OF THE RESULTS OBTAINED FROM QUESTIONNAIRES, EVALUATION SESSIONS, AND EVIDENCE OF STUDENT WORK INDICATED (1) THE COMPUTER APPEARED BEST SUITED FOR AREAS SUCH AS ARITHMETIC PROCESSES, ALGEBRA, ADVANCED MATHEMATICS AND PROBABILITY, (2) STUDENTS OBTAINED RESPECT FOR LOGIC AND ORDER AS A RESULT OF WRITING PROGRAMS FOR THE COMPUTER, (3) THE PRECISION OF THE TELECOMP LANGUAGE HAS EMPHASIZED THE NEED FOR PRECISION IN PROBLEM SOLVING, AND (4) THE COMPUTER COULD BE USED TO CLARIFY MATHEMATICS FOR SOME STUDENTS. (RP)

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COMPUTER ASSISTED MATHEMATICS INSTRUCTION

Pilot Project

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Connecticut State Department of Education

Metropolitan Effort Toward Regional Opportunity

SE 003 948

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PART ONE

Objectives

Initial experimentation is with the use of a large scale computer as a means of teaching mathematics. We feel that this technology has implications as a teaching aid in other subject areas, e.g. science, social studies, language, etc.

Basic questions to which we seek tentative answers are:

1. How can mathematical understandings and logic be taught more effectively with the use of this tool?

2. How can the computer be programmed to act as a useful instructional aid?

3. What training is necessary for teachers to enable them to use this tool successfully?

4. What implications does computer instruction have for various areas of the curriculum and other age groups?

Objectives:

1. To make it possible for the students participating to effectively operate the data phone to put in and get answers from the Computer.

2. To insure that the students are familiar with the Computer language (Telecomp) and are able to write an original program and use an existing program.

3. To be certain that the apparatus is used as an instructional tool, not as a toy or solely as an extracurricular device.

4. To appraise the feasibility of using a time-shared computer system.

5. To develop programs, tools and aids which will be of value in the instruction of mathematics.

6. To afford teachers an opportunity to become familiar with the language and operation of a computer which may be used as an aid in the teaching of mathematics.

7. To determine the feasibility of processing school administrative applications by this computer.

8. To determine, by solicitation of student and teachers, the effectiveness of the program. Distinction should be made between enthusiasm and knowledge.

PART TWO

Historical Background

On May 29, Commissioner William J. Sanders wrote to Dr. John E. Deady, Superintendent of Schools in Wethersfield, the town administering the METRO project, to develop procedures, on the basis of cooperation between the METRO project and the Connecticut State Department of Education, for the handling, by electronic data processing and computers, of the tremendous amounts of data about pupils, staff, curriculums, facilities and finance necessary for the adequate and continuous appraisal of education. He pointed out the Department's activities in state and national efforts along these lines. He also asked to be associated with the METRO project and offered the assistance of departmental personnel in advancing METRO objectives.

On June 6, Commissioner Sanders wrote again to Dr. Deady to inform him and the METRO management that the Department was about to enter into a contract with Bolt, Beranek and Newman, Inc., of Cambridge, Massachusetts to investigate uses of a time-shared computer, located in Cambridge, for (1) computer-assisted instruction in mathematics, and (2) other uses by administrators. After a three month period for planning and preparation, it is anticipated that teletype terminal devices for input and output may be installed in two or three secondary schools. It is hoped that METRO will participate in this investigation by (1) accepting installation, at state expense, of a terminal in one or more secondary schools, (2) involving one or more mathematics teachers in the project, and (3) involving one or more local school administrators in the project.

On June 16, four members of the State Department of Education met with the Superintendents' Advisory Committee and John Allison, the Project Coordinator for METRO, to discuss some of the details which might be involved in the proposed relationship between METRO and the Department. Conversations centered about specifics of the activities relating to computer assistance instruction in mathematics, since it was generally felt that considerable activity is already under way with respect to administrative uses of data processing equipment and computers.

On July 19, the communities of Bloomfield, Manchester and Meriden were selected from the ten METRO communities expressing an interest in participating in the Computer Assisted Mathematics Instruction project.

PART THREE

Teacher Training

With actual use of the dataphone connected to the computer in Cambridge, each morning teachers learned how to operate and program the machine. Afternoons were devoted to curriculum seminars to plan the actual use of the device in the classroom situation. Instructors and discussion leaders were Mathematics Specialists from the Connecticut and Massachusetts State Departments of Education, public school teachers who had teaching experience with the apparatus, and technical and academic experts from Bolt, Beranek and Newman, Inc.

Teachers' Workshop:
August 15, 1966 August 19, 1966
Hartford State Technical Institute

Instructors

Elizabeth Glass	Connecticut State Department of Education
Jesse Richardson	Massachusetts State Department of Education
Norman Doelling	
Wallace Feurzig	Bolt, Beranek and Newman, Inc.
Richard Grant	
Cynthia Solomon	
Walter Koetke	Lexington, Massachusetts Public Schools

Participants

Joanne Fontanella	
Juris Zars	Bloomfield
Rosamond Toomey	
Richard Danielson	
Blaine Miller	Manchester
Paul Juttner	
Ronald Scott	
Herman Dressler	
Raymond Wodatch	Meridan
Thomas Bruenn	
Eugene Zahnke	Bristol
Warren Parnell	West Hartford
Raymond Baine	Glastonbury
Estelle Pelletieri	
Frank Metcalf	Wethersfield
Lawrence Mucci	Southington
Mary Brakoniecki	Rocky Hill
Esther Unkel	University of Connecticut
George Miller	Central Connecticut State College
Herman Moeller	LEARN
George Muro	SPRED
Richard Bigelow	Hamden
Roger Richards	
Maurice Ross	Connecticut State Department of Education
James Naughton	

PART FOUR

Personnel, Equipment, Funds

1. Dates: July 1, 1966 December 31, 1966
Workshop August 15, 1966 August 19, 1966
Apparatus installed October 3, 1966

2. Personnel:

Connecticut State Department of Education

Dr. Maurice Ross
Dr. James Naughton
Mr. Frank Livak
Miss Elizabeth Glass

METRO

Mr. John Allison

Participating Communities

Bloomfield (Bloomfield High School)
Miss Joanne Fontanella
Mr. Juris Zars
Manchester (Manchester High School)
Mrs. Rosamond Toomey
Mr. Richard Danielson
Meriden (Platt High School)
Mr. Thomas Bruenn
Mr. Herman Dressler
Mr. Raymond Wodatch

Bolt, Beranek and Newman, Inc.

Dr. Richard Bolt
Mr. Norman Doelling
Mr. Wallace Feurzeig
Mr. Walter Koetke
Mr. Richard Grant
Miss Cynthia Solomon

Massachusetts State Department of Education

Mr. Jesse Richardson

Southern New England Telephone Company

Mr. Frederick Rowback

3. Equipment:

Terminal Teletypewriters Bell Telephone and Telegraph Model 33 ASR Teletypewriter with Dataphone (3)

PDP 1 digital computer located at Bolt, Beranek and Newman, Inc., Cambridge, Massachusetts

4. Funds:

Title V, P.L. 89-10, through the Connecticut State Department of Education	7,000.00
Title III, P.L. 89-10, through METRO	750.00
	7,750.00

IV A

Responsibilities of Local School Systems

1. Local systems provided space for the teletypewriter in a secondary school classroom. The exact grade was determined as specific teachers for the project were identified.

2. The participating teachers (1 or 2) in each system were identified and required to take one week of training for this program. The training took place during August 1966. The State Department of Education provided the funds for the instructors and the facilities for the training program. METRO paid each teacher a stipend.

3. Each school used the time shared equipment on line 2 hours per day during school hours and 2 hours every third day after school hours.

4. Participating teachers were released regularly for seminar meetings with staff and consultants from other schools and the State Department of Education for the duration of the project.

5. Participating teachers and systems permitted observation by prior arrangement by State Department personnel and by others who were interested, e.g. mathematics teachers and administrators from other school systems.

6. Participating systems and teachers assisted (a) in determining the types of evaluations and follow-up which may be feasible in the 6 month or 8 month period and (b) in carrying out the evaluations.

PART FIVE

Structure of the Project

Two mathematics classes were set up in each school designated for participation. Children were instructed in the use of the Teletypewriter and the Telcomp language.

Telecomp is a user-oriented programming language so designed that it can be learned readily by teachers and students who may have no previous experience in computer programming. The user and the Telecomp systems communicate via a teletypewriter in reasonably national English, as well as in mathematical notation that is so close to the normal notation used in schools.

The students, sitting in various schools in this and other participating states, type numerals, letters, and other symbols found on the keyboard. They work their way through to the solution of a mathematical problem, or test a theorem or practice solving equations. The Telecomp system communicates with the pupil, aids him in describing and performing his calculations, and gives him rapid feedback in the form of answers or of comments concerning errors or inconsistencies that the student has committed.

Telecomp was used (1) to assist in the discovery approach to help motivate students and to develop the understanding of mathematical concepts, and (2) to emphasize the analysis of problems into sub-problems, and (3) de-emphasize the routine drill approach to mathematics.

5 A

Seminars

September 15, 1966
October 11, 1966
November 3, 1966
November 29, 1966
December 14, 1966

The teachers using the computer in their classrooms met regularly to:

Schedule the use of the time shared computer
Discuss classroom experience with the computer

share successes
air problems

Talk with Bolt, Beranek, and Newman, Inc. experts about computer use
Plan demonstrations
Evaluate the project

Elizabeth Glass (Connecticut State Department of Education) and John Allison (METRO) also participated in the seminars.

V B

Demonstrations

In addition to using the computer in the classroom, participating teachers demonstrated it to other staff members in the school systems housing the apparatus, to non-public school personnel, to interested students, and to the delegates at the National Council of Mathematics Teachers Convention held in Hartford on November 11, and 12, 1966

PART SIX

Via

Summary of Questionnaire

1. Were students able to operate the dataphone in terms of putting programs in and getting results out?

   The overall opinion was that students were able to operate the equipment. The type of programs utilized appeared to depend on the ability level of the student and the time he had on the equipment. The more imaginative and creative students reached a higher degree of sophistication on the machine and in writing programs.

2. Were students able to write workable programs?

   Students needed assistance in writing programs. In each location there were individuals who were sufficiently enthusiastic and motivated to do a great deal of independent work on programming problems of interest to them.

   (See Section VI C)

3. How was the computer used as an instructional tool? (Was a specific topic introduced with the computer? Did the use of the computer foster the further investigation of a topic, etc?)

   Some of the specific area in which the computer was used in instruction include: prime numbers, quadratic equations, nth terms and other formulae, finding factors, and probability. It was used by students in their chemistry laboratory work, solving physics problems and as a general problem solving device. In some instances, students were interested in pursuing an idea beyond their experience because of their experience with the computer. (e.g. The program for the solution of a second degree equation would lead to the question" Could you write a program to solve a 3rd degree, a 4th, an nth?)

4. What areas of the curriculum seemed best suited for computer work?

   It appeared that most people felt that a student needed at least a year of algebra as background and that there was a dominant computational aspect to the use. It appeared best suited for areas such as, arithmetic processes, algebra, advanced methematics and probability.

5. Was the computer used as an extra curricular activity? (With a math club, with interested students , not in classes involved, etc.)

> There was a wide variety of use from school to school. Much was done with interested students not in the assigned classes in the after school situation. The work was demonstrated to other teachers, other departments, etc. More of this type of activity was planned, but time was a limiting factor.

6. What by-products in terms of learning did you observe related to the experiment?

> Some of the specific items mentioned were: enthusiasm, development of logical thought problems, learning by error, and the importance of preciseness of thought.

7. Did the use of the computer clarify the mathematics involved for any students?

> "I think that the logical method of approach mentioned was the most beneficial result of the experiment. Even students who wrote the most simple programs learned the need for order and logic."

> "Order of mathematical operations was clearly straightened out for many. Some students had come to realize that thinking and organization are as important in mathematics as mere computation and manipulation."

> "In most cases, it reinforced material to which they had already been exposed. One student was motivated to investigate some deeper aspects of trigonometry. For one student, linear programming led to investigation of systems of 3rd and 4th degree equations. One student investigated base number conversions."

> "Each class project afforded the student a deeper insight into mathematics. The precision of the programming language made them become more organized in their routine assignments."

8. What mechanical difficulties were encountered with the system? (Indicate those that seriously affected the usefulness of the computer as a teaching tool?)

> In all locations, the major difficulty was with the availability of the computer. The local installation worked well. The problem of not having the system available at the assigned time made it difficult to utilize during class time. "While the computer was supposed to be available on line at a given time daily,

much too frequently we found we could not be connected due to 'heavy use by others', 'change over in wiring', 'breakdown of equipment' etc." Disconnection during the execution of a program was a frequent difficulty.

9. What administrative problems affected the use of the equipment?

One school ran into problems of rotating schedule, extra curricular interference and administrative procedures. Another school had some difficulty because of the location of the equipment. In all cases, it was felt that if more time could have gone into the planning of the project, many of the difficulties could have been ironed out. Many adjustments were impossible at the late date.

10. What attempts, if any, were made to extend the experiment to other schools, other staff members, other pupils? (Describe what was done, the difficulties involved and what was accomplished)

Invitations were extended to other school systems, but in most cases, these were not honored because of the shortness of time. Demonstrations were put on in most schools for interested staff members, but this could not be followed up. In one town, there was a demonstration for the community college. The time and the limited availability of the equipment presented the greatest difficulty.

All three schools participated in a demonstration at the National Council Teachers of Mathematics Convention in Hartford. Each school was scheduled for a two hour block of time, but in all cases, they ran over because of the interest of the group.

11. What outside resources, if any, were utilized to enrich the experiment?
(What were they and how were they used?)

The schools have made use of the movie "Quicker Thank You Think". One school had a guest speaker from the Travelers Research Center and followed this up with a field trip to the center. Other schools have purchased supplementary materials in the form of books and periodicals for use particularly by the students in the computer program.

12. Was the in-service training for the staff, carried on during the summer, of value?
(In what ways could such an endeavor have been more profitable?)

In all cases, the people envolved in the project felt that they could not have started in the fall without the summer experience. However, they felt that the time was much too short. It should have been a much more structured session with a specific course in Telcomp including problems and work on the machine. Some of the difficulties seemed to stem from the fact that most of the instruction was given by non educators who were not able to see this in the classroom situation. It would have been helpful if after there was familiarization with the machine time they could have been spent in developing programs and a course of study for the classroom situation.

13. Was the monthly seminar meeting of value to the participants? (How could it have been structured to be of more value? Was the number of meetings sufficient?)

The concensus seemed to be that the number of meetings was sufficient and that the opportunity they provided to exchange ideas was most valuable. It was suggested that perhaps a meeting at one of the terminal sites with the BBN technicians available would have helped to iron out mechanical problems.

14. Do you feel that this experimental program has been worthwhile?

"It has been very interesting and stimulating to a few, but I do not feel that, as it had to be taught due to time limitation, it has been beneficial to the group as a whole".

"It has broadened their knowledge of mathematics for those students involved. It has given them an opportunity actually to use a computer. It has given them an awareness of the foundations of programming a problem. The precision of the TELCOMP language has emphasized the need for precision in problem solving. It has made some students aware of an important aspect of modern technology. It has made mathematics seem more practical and more meaningful than a daily homework assignment".

15. Would such an experiment be worth continuing?

The feeling appears to be that the program should be continued, but with some modifications and with some assurance that we would be able to overcome the computer difficulties. The group expressed the feeling that in these first months they were just getting ready to really use this tool and would now like the opportunity to see what could be done.

"What we have accomplished in these three months has served merely as a start on a long road. The information gained thus far can best be put to use now. The errors of the past will help to plan better ways of instruction, better choice of materials and better project".

16. If there was a continuation, what changes would you recommend?

Some of the suggestions made are as follows:

Computer mathematics should be incorporated into the regular program, and the mechanics of programming taught as an elective course.

The computer should be available to the school at all times.

Lightened load for the teacher working with the experimental program.

Location of the equipment so that it can be utilized at all times on line or off line.

Extended summer workshop to develop materials for such a program and investigate the possible places for inclusion in the regular curriculum.

VI B

Taped Evaluation Session

An Evaluation of the Computer Assisted Mathematics Instruction Pilot Project Sponsored Jointly by the Connecticut State Department of Education and METRO

Miss Elizabeth Glass - Mathematics Consultant - Conn. State Dept. of Education

Dr. James Naughton - Bureau of Research, Statistics and Finance - Connecticut State Department of Education

Miss Joanne Fontanella- Mathematics teacher - Bloomfield High School

Mr. Herman Dressler - Mathematics Department Chairman - Platt High School - Meriden

Mr. Richard Danielson - Mathematics Teacher - Manchester High School

Mr. Thomas Bruenn - Mathematics teacher - Platt High School - Meriden

Mrs. Rosamond Toomey - Mathematics Department Chairman - Manchester High School

The following is taken from a discussion held December 14, 1966 by the persons listed above. What follows is not necessarily verbatim quotes, but is very close to what was actually said at that meeting.

E.G. - Were students able to operate the dataphone in terms of putting in programs and getting results out?

J.F. - Almost any student could make up some type of program and put it into the computer, find an error or two, correct the error, and then come out with a successful program. The more imagination and creativity the individual had, the better he was able to set up a program, and the more he got from working with the machine.

T.B. - The question may not be as pertinent to programs as to the use of hardware. Most students had no problems. Occasionally they had problems with which button to push, which number they should call and what happened when they couldn't get through to Hartford they would have to realize they must call Cambridge. They always got a little nervous when it wasn't working perfectly. Most students didn't have any difficulty; they are used to machines.

R.T. - There was quite a difference in the number who were keenly interested. Only 4 out of 22 in the class were really interested; 10 more moderately interested. They (the 10) learned to put in a program. The rest did what they had to do because I required it.

E.G. - Did you have any experience with anyone that basically couldn't learn to operate the equipment?

T.B. - Two students were put on the machine. Whether it was due to the fact they didn't want to do it or whether it was the easiest way out, or whether it was their inability to do it, but for some reason they were told to dial a certain number, they would do it and get on the line but they would have problems. For example, they would press the wrong button even though they knew which one to use. They would type incorrectly, forget to put in "delete all". It may be a problem of being afraid of the machine. The two students didn't want to type on the machine because they were afraid of it. I found no way of overcoming this fear. They were afraid of making a mistake.

J.F. - The fear of the machine was quite common. People were very reluctant to sit down and start typing. Once they found they could press buttons and make things work, they were willing to do this. I found this so with a group of math teachers we had at two training sessions. They were afraid.

T.B. - Commented on having difficulty getting on the machine when he tried for a teacher training session, B.B.N. was having problems.

E.G. - Do you find the students are much more willing to try it now than they were six weeks ago?

- Yes

R.D. - Students were cutting their own tapes with no one in the room at all.

E.G. - Were students able to write workable programs? - We have samples of programs that demonstrate that students were able to write workable programs.

T.B. - I used in Algebra I to teach equation solving. I presented a problem to two students in Math I who never understood what an equation was, and they wrote a program. They were quite surprised that they could take something they didn;t even know about, and they could write a program for the machine to do it. It was basically a 5-step program.

E.G. - We have found that, as far as the use of the machine and the introduction to programming is concerned, the program doesn't necessarily have to be a complicated mathematical problem. Can get the idea across with something that is relatively simple.

How was the computer used as an instructional tool? This was our main objective but probably the last objective we would get to because much time had to be spent with mechanics. Any evidence this was used as an instructional tool and in what particular area?

H.D. - One student used the computer to solve a problem in Physics. He wanted to find a result of any number of vectors, and he spent a great deal of time with Tom. The student did a good job with this.

R.T. - Four students who were fighting to get to it to do their Chemistry lab. They found it worked out beautifully. They could set up their plan and put all their information in and get their results in table form. They used it extensively for that purpose. They did it on their own.

J.F. - I had a similar situation in Physics where there are lots of formulas which are relatively simple to program.

T.B. - In a Math I, I wrote two programs to test communitivity of additon and socialitivity of multiplication. With this program, given any two or three numbers, the machine would do it quickly for them and everyone had a chance to test out what they thought it was, and they were quite impressed because in this case it would work with every number they thought of. But they did get to the idea that the machine couldn't do every problem because of infinite numbers.

E.G. - Could this be the start of an investigation of something beyond what they were doing? I was thinking of Bloomfield in particular where some students were doing some work with quadratic equations. The question arose in the minds of the students: if you can do this with quadratic equations, would it be possible to write programs for equations of higher degree than this? Even though this wasn't part of their curriculum, the interest was there to pursue this a little further.

J.F. - One student was motivated to doing work in Trig. The spectacular graphing that the machine does impresses them so. One student wrote several programs to find the roots of polonomial functions higher than the degree 2. Another student extensively investigated base number conversions.

E.G. - From your experience with it in this short period of time, do you have any thoughts where this particular kind of tool would best fit into the traditional curriculum? Say 9th grade Algebra level, Senior classes of advanced math, etc.?

H.D. - The student who worked on the problem of finding the result of any number of vectors found that because he just began the course in Trig., he was limited in what he could do. When he first worked and used degrees, he found the computer couldn't solve the problems because he had to know something about radian measure. He also had to know how to work with inverse functions. Therefore, consulted Mr. Bruenn.

The computer would be very helpful in setting up programs in Trig. I can also see the value in using a terminal to solve a number of problems in integration and the Calculus. I find, in talking to different teachers, that it is quite difficult to set up problems in differential Calculus, but it could be used as a good instructional tool in the Calculus integration.

R.D. - We were working in the area of Algebra II solution of equations and the use of the quadratic formula. I am just getting ready to write programs to do this

and the pilot project is terminating. We got them so they can operate the machine. Last week, they had their first problem: find the solution of a quadratic. That's all I said to them, and 8 out of 14 came up with a program that worked. I gave them no help on the computer. They wrote it during the week, put it in the computer Friday, and were surprised that it came out. It did work. I had hoped that the project would continue. After Christmas, we would do real work in Algebra.

T.B. - I'm convinced that the more mature the student, the better the machine is. The 11th and 12th grade levels would be the best place for this machine. In the 9th and 10th grade, the immature students look at the machine as a toy. Even though they write the programs, and put them in, they like to have the machine write to them; you see in the program the statements type "meet me down stairs for a coke, etc.".

E.G. - Has anyone done anything in the field of Geometry?

T.B. - The machine can't do much except for graphing.

H.D. - It could be used in coordinate Geometry.

R.T. - I couldn't find many places where I could use the computer in Trig. except, perhaps, in logarithms and law of sines which we haven't come to yet.

T.B. - I used it for General Math. Most programs can be written for this machine, but it is as fast for the student to do General Math in his head as to use the machine!

E.G. - Has anyone used the computer as an extra-curricula activity? E.g., Students using it that are not in the class but using it on their own like a Math club or just because they were interested?

R.T. - Two most interested students weren't in class. They took the books and studied it and did it all on their own. They put far more time in it than people in the class.

J.F. - A Senior class of 7 continually asked about it and wanted to have time. That's when I borrowed time from Manchester and Meriden. Seven people were very interested, particularly four of the seven. They were a high ability group and picked up the techniques very fast.

H.D. - One student came in after school and worked a great deal with Tom on his program. He showed a great deal of interest.

E.G. - Were there any by-products in terms of learning or in terms of techniques that came out of this experiment?

T.B. - A typing teacher came to me and said since a few of their girls were using this machine, they were getting better marks in typing. They were taught that you don't have to have the same keys on every typewriter. Because our symbols were different in many cases, the girls were able to switch back and forth between the two machines they had in the business department.

E.G. - One by-product I was thinking of is the techniques in handling the class. They seem to be quite different from what we think of as the stereotype classroom situation with the teacher using mostly the lecture recitation approach. The class had to be organized and perhaps run quite differently when you were grouping within the class situation in order to make maximum use of the machine. Perhaps this forced us into another pattern of teaching that might have implications.

J.F. - I find it difficult to convince the students of the value of preciseness, they tend to be careless about certain things and signs. I think the machine emphasizes the need for accuracy.

R.T. - I think they learned by the errors they made with these machines. If the project helped them at all, it probably helped them in the development of logical thinking.

E.G. - Did you have any evidence that the use of the computer clarified the mathematics involved?

R.D. - In my group, they first came in thinking mathematics was a matter of computation and mechanical manipulation. I think they are firmly convinced now that you have a lot of thinking and organizing, pre-writing work to do. You don't start writing; you do a little thinking, and then you don't have so much writing to do. This is a big thing my kids picked up out of this.

E.G. - This we hope might have some carry over into a regular classroom type of situation. Again, if they would take some time to read the problem and think about it first before they start putting down equations on paper, it would help.

E.G. - What mechanical difficulties were encountered? We don't want to be too picayune at this time. Think in terms of major things. Are these things we had difficulty with at the start, and yet maybe we have learned from them? Also the technicians involved have learned to deal with the mechanical difficulties.

R.T. - I would feel that we found the service undependable. We need the machine when we are teaching mathematics for certain definite and limited, very limited, time.

If an assignment is made for the next day, and when we go to use the machine for the 20 minutes, we have available that next day, the machine is not available, and they say "we'll call you back in half an hour," this is of no value to us, and it has spoiled the effect in your whole program. This happened many times.

T.B. - I wouldn't add anything to that, except that I would like to see a suggestion that somehow BBN, or whichever company plans on running this, could let us know when they are having trouble with the machine so that we could change our plans. This is the most important thing. When you set up a lesson plan, and you can't use the machine, it ruins everything.

J.N. - On that score, were definite periods assigned to each school each day? They weren't always honored?

R.T. - That's right. They were not honored in the sense that one afternoon our school had the use of the machine. It was our afternoon to have it. Our youngsters didn't get in right on time. They were typing off line to save money and so forth. When they did go in, we found that there were no lines available because they had given our line to New Jersey.

J.F. - I agree with Mrs. Toomey.

E.G. - This was the major mechanical problem. Were ther any mechanical difficulties with the equipment, the hardware itself, other than getting on line?

R.D. - Yes, I tried to put the tape in and it wouldn't go, I called the telephone company, and I happened to be going back to my desk after they said they would be over. I banged the tape on the table as I went by. The tape had just been warped. It flattened out and went right into the machine perfectly with no problems.

E.G. - Were there any administrative problems?

H.D. - We are on a rotating schedule, and it was not possible to use the computer daily.

J.N. - It was very difficult because the class that was initially scheduled for the use of the computer would not be on that time which was assigned to them.

T.B. - We arranged it for two classes in the same type of subject to use it but three out of seven days they wouldn't be meeting those two periods. That's why we could afford to give up some time to another school.

E.G. - Did you run into any difficulty in Meriden with the after school time?

T.B. - We were able to work around that. Schools didn't get out or close until 4:30.

E.G. - Were there any other administrative difficulties involved?

T.B. - This may not be administrative, but the student had to make a choice between another extra curricula activity after school and the computer. In many cases, he chose the extra curricula activity.

J.N. - If in Meriden both high schools had been using this, would this have complicated the picture just that much more in terms of accessibility to the computer?

T.B. - I think you would have to make a judgment on which class in the other school would be using it. If you could arrange it to mesh rotating schedules, it would work out perfectly. You would have to correspond every week to make sure you had the right classes meeting at the right time. It would require another dataphone installation.

R.T. - I thought the biggest problem resulted from the installation of the program at the last minute. It had to be taught in addition to a regular course. I taught it in a course which can permit college credit at U. Conn., therefore, I could not give the computer all the time I might have.

E.G. - What attempts if any, were made to extend this experiment either to other schools or to other staff members? I think you did this with some of your staff in Bloomfield.

J.F. - Yes. We found that with the normal load of teachers, that it was difficult to set up any concentrated training program. We gave just two lessons, and teachers were very receptive. But it did not work out quite the way we had hoped.

H.D. - We had one in-service meeting with the two staff of Platt and Maloney. The staff at Maloney was invited to use the terminal, and no one took advantage of the offer. They have a number of people that are highly qualified to work on this, but they did not use it.

E.G. - What was Manchester's experience in this area?

R.T. - I invited both East Catholic and South Windsor (Miss Duffy) to come in for observation, demonstration and participation. Neither of them accepted. Two of our students are giving a demonstration to students of the Manchester Community College in basic computer machinery. We conducted in-service for our own staff.

T.B. - We domonstrated it to the students in the business department who were interested in it. Their machines are IBM and use direct punch. Our machine uses an indirect punch method.

E.G. - Were there any outside resources used?

R.D. - A staff member of the computer center at Travelers gave a very interesting lecture on programming to the students. Ted Blakesly is always available from Trinity. We get notes from him quite frequently from the engineering department of Trinity. He was most helpful.

R.T. - We had a film on the computer, "Quicker Than You Think", which was put out by Columbia University. We also have a field trip of 25 students going to the Travelers Research Center to see their computer.

J.F. - I had arranged to have a field trip to the Computer complex at Combustion Engineering, but I'm sorry to say that I haven't organized it and it looks as if we won't be able to get there.

E.G. - Bloomfeeld has close proximity to Conn. General which would be another possible field trip for the students.

What was your reaction to the in-service training for the staff that was carried on during the summer? We need to recognize that this was put together rather hurriedly. Do you think this was of any value? Do you think we needed this?

T.B. - It should have been longer. It would have been better if we had known the type of class in which we were going to use the computer. We could have come in with problems to be discussed. We could have considered presentation and programming of problems. Rather than what we did which in many cases didn't allow time to use the machine. The first week we got the machine in the classroom the teacher was spending time on it, not the student. If it were a longer program or a more precise, (one or the other) and not necessarily the type that was presented to us, it would have been better.

H.D. - I needed more time on the machine.

R.D. - I would like to have seen it run two weeks, perhaps a half a day instead of a full day as it was. We didn't feel at home with the machine when it came into the class. We needed the practice on the machine.

J.F. - I wrote down six specific points. My first comment was that the program was of value, because that was the only way we could find out about the machine. It could have been more profitable. It could have been set up

in the following way: No. 1, the presentation of a language; No. 2, the assignment to read a section from the manual; No. 3, the assignment of representative problems referring to those sections; No. 4, suggestions of areas for which programs could be constructed; No. 5, information about specialities of the machine-such as sorting techniques; No. 6, ways the machine has been used in actual instruction in Massachusetts.

J.N. - The people who were basically responsible for the workshop were not educationally oriented. In Massachusetts, procedures were strictly operational. Useage was coming from hospitals, and BBN was handling it within their own computer center.

J.F. - I had attended the Kent School program which was given by General Electric personnel, who were not essentially education people either, but their program was more organized and better presented.

E.G. - This (Kent/GE) was a situation where they had people whose direct responsibility was this kind of endeavor. The people we worked with, were doing this for the first time. Do you think the monthly meetings and seminars we had were worthwhile in the initial stages?

H.D. - When you attend a meeting of this type, you get the reactions of other people working on the program. I think this has great value.

T.B. - We could have discussed our problems a little more as far as specific programs are concerned. We didn't do this enough.

R.D. - I think, if we had a workshop with BBN present, and if we could actually show them the program on tape and show them it doesn't work and ask them what is the problem, we would have learned more from the sessions.

T.B. - They said we could send it to BBN, but we would want to know what was wrong immediately and not have to wait for a week while they work on it through the machine and send it back to us. By that time the class might have left.

E.G. - What was your feeling as far as the number of meetings we had?

R.D. - I don't think we need to increase the frequency.

E.G. - What would be your feelings were we able to continue the experiment, for instance the second semester? Do you think there would still be a need for periodic meetings? Or do you think that this kind of thing is not necessary now that we know what we are doing?

R.D. - I think we should still keep in touch. I don't feel that we should go our own way, we are not that expert yet.

E.G. - Less frequently but have the opportunity to get together. Perhaps a workshop with BBN would be worth thinking about. Do you feel that the experimental program was worth undertaking, in spite of the mechanical difficulties and so forth?

J.F. - I think the program was worthwhile for several reasons, first of all it exposed a number of students and teachers to a computer. It gave the opportunity for individual study. It was a very great motivational tool. Just the fact that it could illustrate the possibilities that a man can achieve was worthwhile.

R.D. - I heard a comment from one of my students before class. He said "I heard that machines were going to take over the world, but by golly it takes more than a button to make one of these things work." They got the idea that there are definitely going to be places for people in this world who can operate the machines.

T.B. - We were discussing that it may get to the point that the colleges will require the students to have this knowledge before they come into the colleges.

R.T. - I think it has been very interesting and stimulating to a few, but for the expense and the fact that it had to be taught in such a limited time, I really don't think that it has been beneficial to the group as a whole. I shouldn't say it hasn't been beneficial; I'm sure that they got something out of it, but perhaps it hasn't been worth what it has cost.

E.G. - Is such an experiment as we have had worth continuing?

J.F. - I think it would be worth continuing, but I also agree with Mrs. Toomey. I think perhaps a suggestion might be set up a course called "Computer Work" or "Learning the Computer" or have it exlusively devoted to programming and work with the computer. Then I think we would find that our subject matter would not be put aside or reduced.

H.D. - A course in Computer Use, oriented to mathematics, should be a regular part of the mathematics curriculum. There should be sufficient teachers with the background and training to work in this area.

E.G. - If there were such a course offered where you would use the machine there would still be, perhaps, opportunities for youngsters to make applications of this in their regular math classrooms within the framework of their regular subject matter.

R.D. - I was just wondering; wasn't the purpose of this "Computer Assisted Mathematics Instruction" and not computer mathematics as such? I'm wondering if we aren't looking at the wrong side of the coin. This was to use the

computer to help us in the math classes not to take it aside and teach strictly mathematics for computer use. I did this, unfortunately, but now I am ready to really use the computer as an instructional tool.

E.G. - Many others are at that point - as we come to the end of the project.

R.T. - I think Dick has given his students a fine background in the use of the machine and I am sure that now they would really take off. I think this is a necessity, this learning the machine first.

E.G. - Do you think this sort of thing would be worth continuing if this is possible?

R.T. - I would answer the last two questions together; if there were continuation what changes would be recommended? I would answer "On the present basis I wouldn't feel it was worth continuing." But if it could be incorporated into the program and taught as an elective, full semester, subject, there would be enough time to learn the basics and then to make application in the field of mathematics.

J.N. - In terms of dollars (so many times this is a controlling factor.) The time shared aspect of the three different communities working together cooperatively on one piece of equipment located in Massachusetts might be the only reasonable approach to this whole thing of computer technology as far as education is concerned. Was the difficulty of the time sharing aspect insurmountable or of minor consideration?

T.B. - It would be best if each school had one line, because then you could turn it on anytime you want. You could teach it with any course when that course met. But you keep talking about money which is a controlling factor, and as far as time sharing is concerned, I think we get along. It wasn't the best, but it certainly was useful.

J.N. - We also learned that the capacity of another computer might make the type of thing that you are suggesting here much more readily available. This particular computer might have limitations. For example: the weather phone in Hartford handles some 400 calls simultaneously. The sophistication of the BBN computer might have limited the type of thing you suggested.

E.G. - This is probably one of the first times that we have had three different communities in three different places working together on a common problem. We would also like to include the service aspect of this experiment in connection with the National Council of Teachers of Mathematics meeting in Hartford. Would somebody describe

briefly what we were able to do in this respect, and thereby, show what was happening andwhat we are attempting to do for many teachers from all levels of instruction. Without our experiment, the NCTM meeting would not have had a Computer Assisted Instruction demonstration.

J.F. - Each school was assigned a certain time to be present at a particular place in the high school. Two or three students from each school were assigned. We had a teletype there on display. Programs were written up and displayed. All this was available for anyone who was attending the conference to observe and to ask questions about.

E.G. - Teachers from all over the Northeast attended (including Pennsylvania and Delaware).

T.B. - Teachers were very interested in the students working on the machines. They would look at the demonstrations time and time again. One man missed a lecture to see the program run again. Of course some teachers paid no attention to it.

R.T. - As a human interest story showing the ingenuity of youth, I must tell this: a girl from Manchester met a boy from Bloomfield, and they learned that they both were putting material into the computer. She would type a message into the machine; he would then get on line and demand that the machine "type all", and he would get her message.

J.N. - You people volunteered for this pilot project. If that question were put to you next fall, what would your reaction be?

J.F. - I would say yes, if they would take one of my classes away. I have put in a lot of extra time (which I don't mind) but I think my other classes were sacrificed because of this.

H.D. - I don't have sufficient time because of departmental duties.

J.N. - How many of you think this should be a separate course included in the mathematics program as opposed to the integration type thing as the program you are now in.

R.D. - I don't think we have the time. Once you get into the Jr. and Sr. years, you are getting ready for the college boards, and time is precious.

E.G.- As you talk about this as a separate course, is there any possibility that it might be introduced earlier than the Jr. years? What about introducing them at the 10th grade level, where they would have the mechanical experience. They could make greater use

of the computer as a tool in the Jr. and Sr. year.

T.B. - I would react to that on the basis of knowing where the students are going later in the curriculum. You could do it on the 10th grade level with college bound students because they would be taking two more math courses. But the general students may quit; in many cases 40% of them do not have to take another math course. If it were to be taught as a separate course, having it three times a week in place of study halls (like Chorus or Art), it might work.

R.T. - I think it would be easy to teach the mechanics of the machine to 10th graders or whatever level. I wonder, if for any meaningful mathematics application, they don't need more background than they have when they are Sophomores.

R.D. - I also think we have a problem we aren't looking at. If we have all these people trained to use the computer and only one teletypewriter to use, we have problems. If we have the interest, we have to provide the equipment to work on or else we are going to lose interest.

J.N. - To conteract this aspect of the fear of the machine, could assimilation take place there on the typewriters in the business department rather than on the machine?

T.B. - You could do it on this basis that the business department has electric typewriters so if they were able to go from their mechanical typewriters to their electric typewriters, I think they would be able to use the computer understanding by that time that it is possible to have different keys on the typewriter. I think much of the fear came from this: when you hit the key of a mechanical typewriter, in many cases you can overcome it if you realize you have made a mistake. With an electric typewriter or a dataphone, you can't overcome it. The business department is quite interested in the machine.

VI C

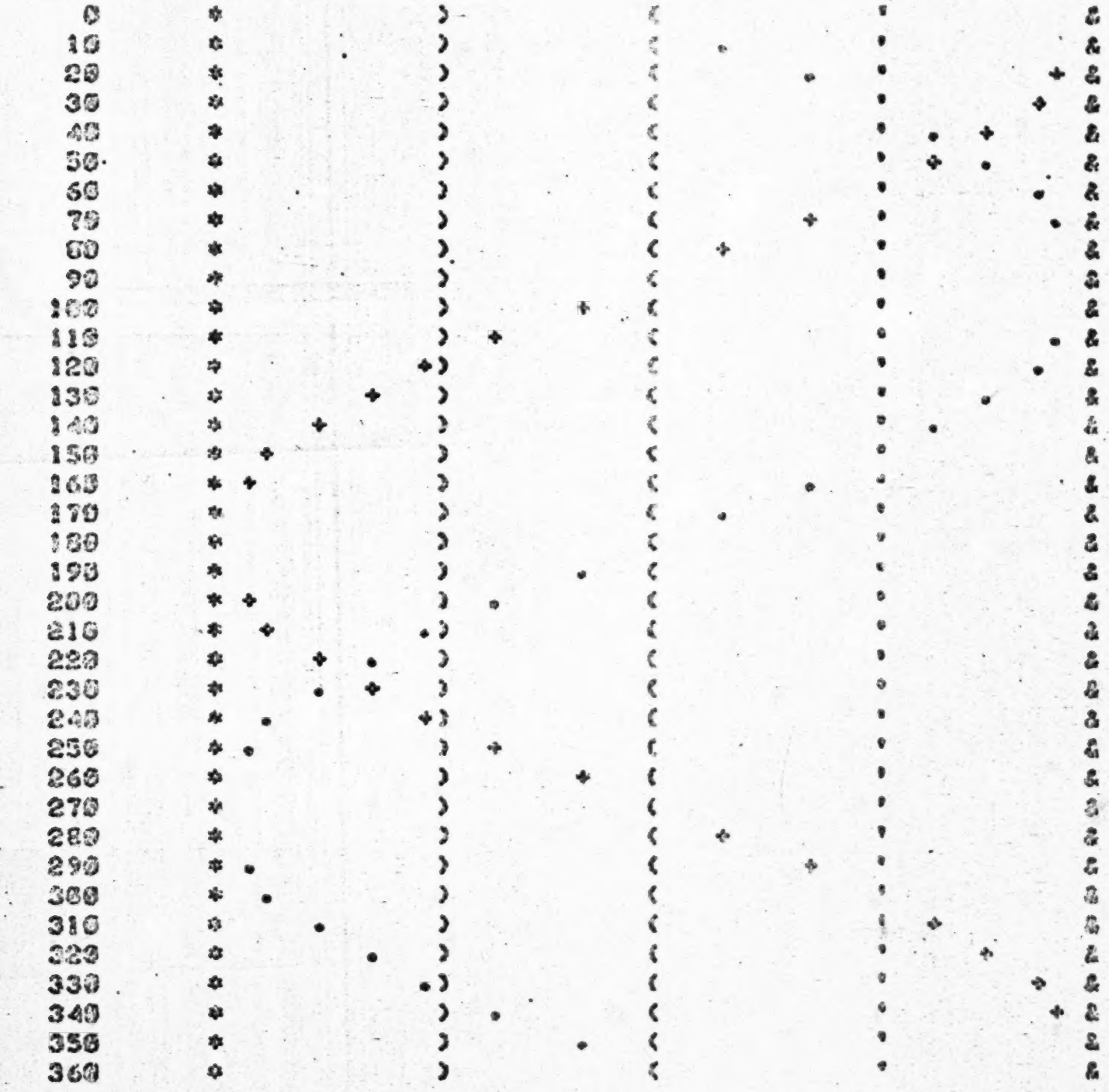
26

```
-1.1 R=DEG*3PI/180
-1.2 PLOT SIN(R), COS(R),-1,--.5,8,.5,1 ON DEG
-
```

Plot of Sine and Cosine

on Same axes

```
 DUMPED
-DO PART 1 FOR DEG=0:10:360
```



Roots of a Quadratic

```
1.1 DEMAND A,B,C
1.2 D[1] = (B*B) - (4*A*C)
1.3 TO STEP 1.7 IF D[1]<0
1.4 D[1] = SQRT (D[1])
1.5 D[2] = -D[1]
1.6 TO PART 2
1.7 TYPE "TRY DIFFERENT VALUES,CHARLIE"
1.8 TO STEP 1.1

2.1 I=1
2.2 X[I] = (-B+D[I])/(2*A)
2.3 TYPE X[I]
2.4 I=I+1
2.5 TO STEP 1.1 IF I>2
2.6 TO STEP 2.2


D
```

Volume of a Cylinder (Odd or Even)

```
1.1 DEMAND H,R
1.2 V=3PI*R↑2*H
1.3 TYPE V
1.4 TYPE "ODD" IF V>0 AND FP(V/2)<>0
1.5 TYPE "EVEN" IF V>0 AND FP(V/2)=0
1.6 TYPE "ODD AND NEGATIVE" IF V<0 AND FP(V/2)<>0
1.7 TYPE "EVEN AND NEGATIVE" IF V<0 AND FP(V/2)=0
1.8 TYPE "WOULD YOU BELIEVE?" IF V=0
1.9 TO STEP 1.1


DUMPED
*DW
RUBOUT
*DELETE ALL
*
```

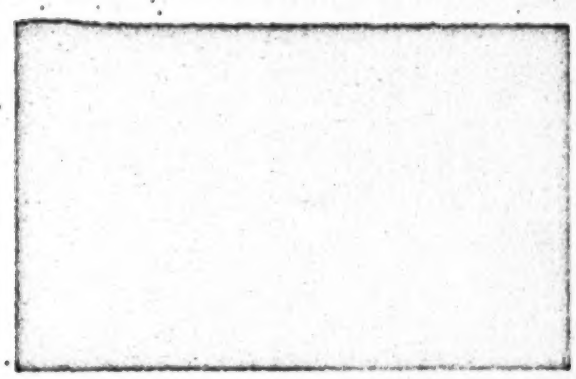
```
6.01;                R'TH TERM FORMULA
6.02; THIS PROGRAN MAY BE ALTERED TO MAXIMUM EFFICIENCY BY
6.03; DELETING STEPS 6.1 ,6.4 ,6.6
6.04;
6.05; TO FIND ALL TERMS OF (A↑EXA+B↑EXB)↑N; DO PART 60
FORM 1
      R'TH TERM = 00000.00 * A↑00.00 * B↑00.00

6.1 TYPE "R'TH TERM FORMULA; GIVE R AND N OF (A↑EXA+B↑EXB)↑N".
6.15 DEMAND N,R
6.2 TO PART 63
6.3 SET TFC=NUM/DEN ; TEMPORARY COEFICIENT OF R'TH TERM
6.4 TYPE " GIVE COEFICIENT OF A(CFA) AND OF B(CFB) IN THE EXPRESSION"
6.45 DEMAND CFA,CFB
6.5 SET COF =CFB↑(R-1)*CFA↑(N-R+1)*TFC;FINAL COEFICIENT
6.6 TYPE " GIVE EXA AND EXB OF THE EXPRESSION "
6.65 DEMAND EXA,EXB
6.7 SET FEA=EXA*(N-R+1); FINAL EXPONENT OF A
6.8 SET FEB=EXB*(R-1); FINAL EXPONENT OF B
@6.9 TYPE #,COF,FEA,FEB
6.925 TO STEP 6.975 IF COF>99999.99 OR COF<-9999.99
6.95 TYPE COF,FEA,FEB IN FORM 1
6.951 DONE
6.975 TYPE "TOO BIG",FEA,FEB IN FORM 1

63.1 SET NUM=1 , X=-1
63.2 SET X=X+1 , NUM=NUM*(N-X)
63.3 TO STEP 63.5 IF X=R-2
63.4 TO STEP 63.2
63.5 SET DEN=1 , Y=0
63.6 SET Y=Y+1 , DEN = DEN*Y
63.7 TO STEP 6.3 IF Y=R-1
63.8 TO STEP 63.6

60.1 DELETE STEP 6.1,STEP 6.15,STEP 6.4,STEP 6.45,STEP 6.6,STEP 6.65
60.2 DEMAND N,EXA,EXB,CFA,CFB
60.3 TYPE CFA↑N,EXA*N,0 IN FORM 1
60.4 DO PART 6 FOR R=2:1:(N+1)

DUMPED
```



COMPOUND INTEREST FORMULA

```
5.1 TYPE " COMPOUND INTEREST FORMULA "
5.2 TYPE " A=AMOUNT P=PRINCIPLE R=RATE T=TIME IN YEARS "
5.3 TYPE " N=NO. OF TIMES INTEREST IS COMPOUNDED IN ONE YEAR "
5.4 TYPE " ENTER ALL VALUES. AFTER VARIABLE TYPE VAR "
5.45 SET VAR=0
5.5 DEMAND A.P.N.R.T
5.51 TYPE #
5.61 TO PART 51 IF A=VAR
5.62 TO PART 52 IF P=VAR
5.63 TO PART 53 IF T=VAR
5.7 TYPE "NO GOOD"
5.75 TYPE "    VARIABLE CANNOT BE COMPUTED "
5.8 SET YES=0 . NO=1
5.85 TYPE " DO YOU WISH TO USE THE FORMULA AGAIN? YES OR NO "
5.9 DEMAND ANS.
5.91 TO STEP 5.4 IF ANS=YES

51.1 SET A=P*((1+(R/N))↑(N*T))
51.2 TYPE A,#
51.3 TO STEP 5.8

52.1 SET P=A/((1+(R/N))↑(N*T))
52.2 TYPE P,#
52.3 TO STEP 5.8

53.1 SET T=(LOG(A)-LOG(P))/(N*LOG(1+(R/N)))
53.2 TYPE T,#
53.3 TO STEP 5.8
```

BUMPED

PRIME NUMBERS

```
1.01 TYPE "FIND A PRIME NUMBER OR FIND FACTORS OF A NUMBER"
1.02 TYPE "TYPE YOUR VALUE OF N WHEN N IS DEMANDED"
1.03 TYPE "PLEASE DO NOT TYPE VALUES FOR N THAT ARE:"
1.04 TYPE "NEGATIVE,FRACTIONAL,OR EVEN NUMBERS, OR"
1.05 TYPE "NUMBERS LESS THAN TEN"
1.06 LINE
1.07 DEMAND N
1.08 SET P=0,A=0
1.09 TO PART 5 IF N<0
1.10 TO PART 8 IF FP(N)>0
1.11 TO PART  6 IF N<11
1.12 TO PART  7  IF FP(N/2)=0
1.13 TYPE "GUESS WHAT?"
1.14 DO PART 2 FOR I=3;2;SQRT(N)
1.15 TO PART 9 IF P=1
1.16 LINE
1.17 TYPE "IT CANNOT BE FACTORED"
1.18 TO PART 9

2.00 DO PART 3 IF FP(N/I)=0

3.00 LINE
3.01 SET FFF=I
3.02 DO PART  4 FOR FF=3;2;SQRT(FFF)
3.03 TYPE "A FACTOR OF THIS NUMBER IS-----"  IF A=0
3.04 SET FAC=FFF IF A=0.
3.05 TYPE FAC IF A=0
3.06 SET P=1

4.00 SET A=1 IF FP(FFF/FF)=0

5.00 TYPE "IT DOES NOT COMPUTE"
5.01 TO STEP 9.00

6.00 TYPE "THIS ONE IS TOO EASY FOR A COMPUTER"
6.01 TYPE "THINK-------AND YOU MIGHT BE ABLE TO FIGURE IT OUT"
6.02 TO PART 9

7.00 TYPE "THIS NUMBER IS DIVISIBLE BY TWO,SILLY"
7.01 TO PART 9

8.00 TYPE "DON'T FOOL AROUND"
8.01 TO PART 9

9.0 TO STEP 1.06
```

DUMPED

TOTAL STOPPING DISTANCE OF AN AUTOMOBILE

AT A CERTAIN SPEED

```
1.1 TYPE "TOTAL STOPPING DISTANCE FORMULA, TSD IN FEET"
1.2 TYPE "RD=REACTION DISTANCE, BD=BRAKING DISTANCE"
1.21 TYPE "AFTER UNKNOWN GRAVITY TYPE 'UNK'"
1.22 SET UNK=-1
1.23 DEMAND MPH
1.24 TO STEP 1.3 IF MPH>UNK
1.25 TO STEP 1.4
1.3 SET RD=MPH/1.1 , BD=MPH↑2/30 , TSD=RD+BD
1.31 TYPE RD, BD, TSD, #
1.32 DONE
1.4 DEMAND RD, BD, TSD
1.41 TO STEP 1.5 IF RD>UNK
1.42 TO STEP 1.6 IF BD>UNK
1.441 MPH=(-100+SQRT(10000+(120*TSD)))/11
1.442 SET RD=MPH/1.1 , BD=MPH↑2/30
1.443 TYPE RD, BD, MPH, #
1.444 DONE
1.5 SET MPH=1.1*RD , BD=MPH↑2/30 , TSD=RD+BD
1.51 TYPE BD, MPH, TSD, #
1.52 DONE
1.6 SET MPH=SQRT(30*BD), RD=MPH/1.1, TSD=BD+RD

1.61 TYPE RD, MPH, TSD, #
```

DUMPED

PROGRAM TO COMPUTE THE GRADES OF MRS. TOONEY'S CLASSES

```
3.1 SN=0
3.15 SN=SN+1
3.2 TYPE SN, #
3.25 DEMAND QG, TG
3.3 DEMAND PT[M] FOR M=1:1:TG
3.35 DEMAND MPT, HW
3.4 DEMAND QZ[I] FOR I=1:1:QG
3.45 SET GOO=0, SPT=GOO+PT[M], SQZ=GOO+QZ[I], FOR M=1:1:TG, FOR I=1:1:Q
3.455 SET QZA=SQZ/QG
3.5 SET GRD=(SPT+2*MPT+HW+2*QZA)/(TG+5)
3.6 TYPE #, GRD, #, #, #
3.65 TO STEP 3.15

DUMPED
```

```
1.3 TYPE N IF FP(N/7)<>0 AND (IP(N/10)<>7 AND FP(N/10)<>.7)
*1.4 TYPE "BB" IF FP(N/7)=0 AND (IP(N/10)=7 OR FP(N/10)=.7)
*1.5 TYPE "B" IF FP(N/7)=0
*1.6 TYPE "B" IF IP(N/10)=7
*1.7 TYPE "B" IF FP(N/10)=.7
*
*
*DUMPED
P*
TERMINATED
*DO PART 1 FOR N=1:1:40
          N=    2
          N=    3
          N=    4
          N=    5
          N=    6
BB
B
B
          N=    8
          N=   10
          N=   12
          N=   13
B
          N=   15
          N=   16
B         N=   18
          N=   20
B
          N=   22
          N=   23
          N=   24
          N=   25
          N=   26
B
B
          N=   29
          N=   30
          N=   31
          N=   32
          N=   33
B         N=   34
B         N=   36
          N=   38
          N=   39
          N=   40
*
```

```
11.05 TYPE "IDENTIFYING PERFECT NUMBERS".
11.1 Y=1.Z=0
11.2 DEMAND X
11.3 Z=Z+Y IF FP(X/Y)=0
11.4 Y=Y+1
11.45 TYPE Z IF Y>X/2.
11.5 TO STEP 11.3 IF Y<=X/2
11.57 TYPE "A PERFECT NUMBER" IF Z=X
11.59 TYPE "NOT A PERFECT NUMBER" IF Z<>X
11.6 TO STEP 11.1
11.7 DONE IF X=0

DUMPED
*
```

CHEMISTRY LAB #7

```
! SC=2*107.870+51.996+4*15.9994
*1.2 TYPE"SC IS FORMULA MASS OF SILVER CHROMATE"
*1.3 TYPE "X IS AVERAGE MASS OF SILVER CHROMATE"
*1.4 TYPE "AQ IS AVERAGE QUANTITY OF SILVER CHROMATE (MOLES)"
*1.5 TYPE "MS IS MOLES OF SILVER NITRATE (10^3)"
*1.54 TYPE "MP IS MOLES OF POTASSIUM CHROMATE (10^3)"
*1.56 TYPE "MSC IS THEORETICAL QUANTITY OF SILVER CHROMATE"
*1.58 TYPE SC
*1.6 DEMAND X
*1.65 AQ=X/SC
*1.7 TYPE AQ
*1.8 TO STEP 1.6 IF X<1.93
*1.9 TO PART 3 IF X>=1.93
*
*2.1 MP=12-MS
*2.2 MSC=MS/2 IF MS/2<MP
*2.3 MSC=MP IF MS/2>MP
*2.4 TYPE MSC
*
*3.1 DO PART 2 FOR MS=1.2;1.3;10.3
*
D\*
```